



Occupant Centric Integrated Survivability



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

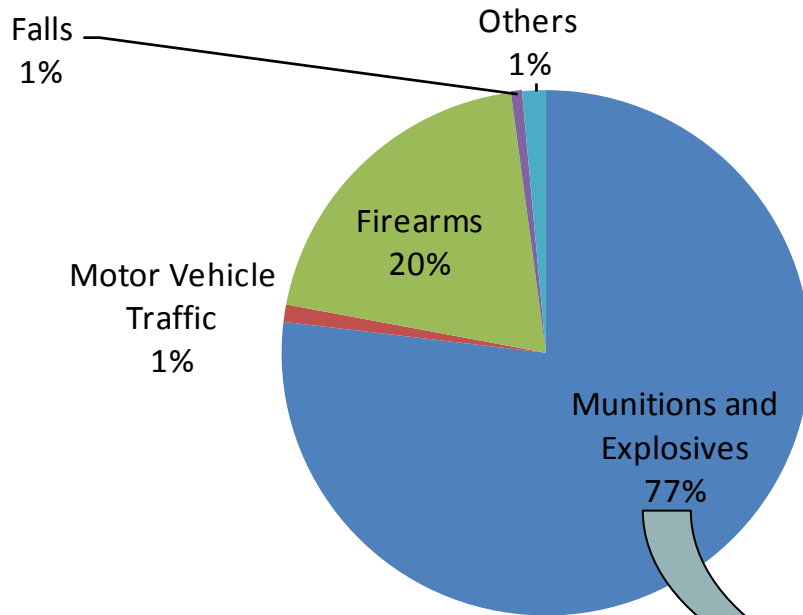
Paul Rogers, PhD
Executive Director
TARDEC Research Business Group

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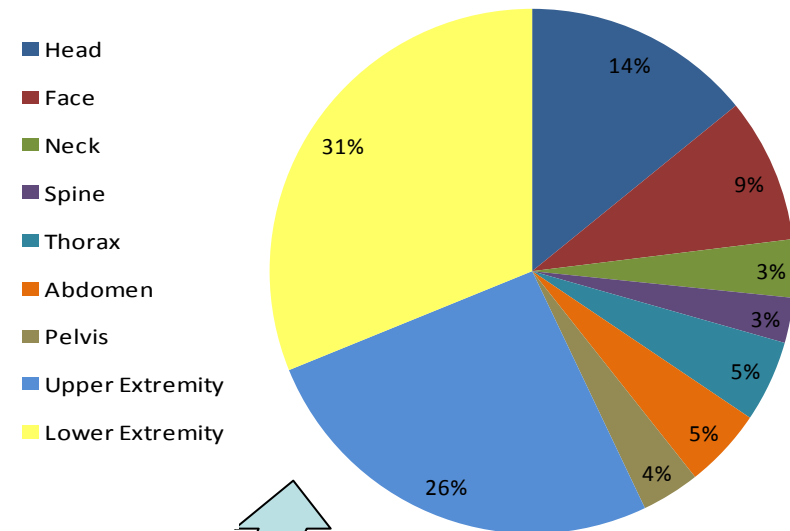
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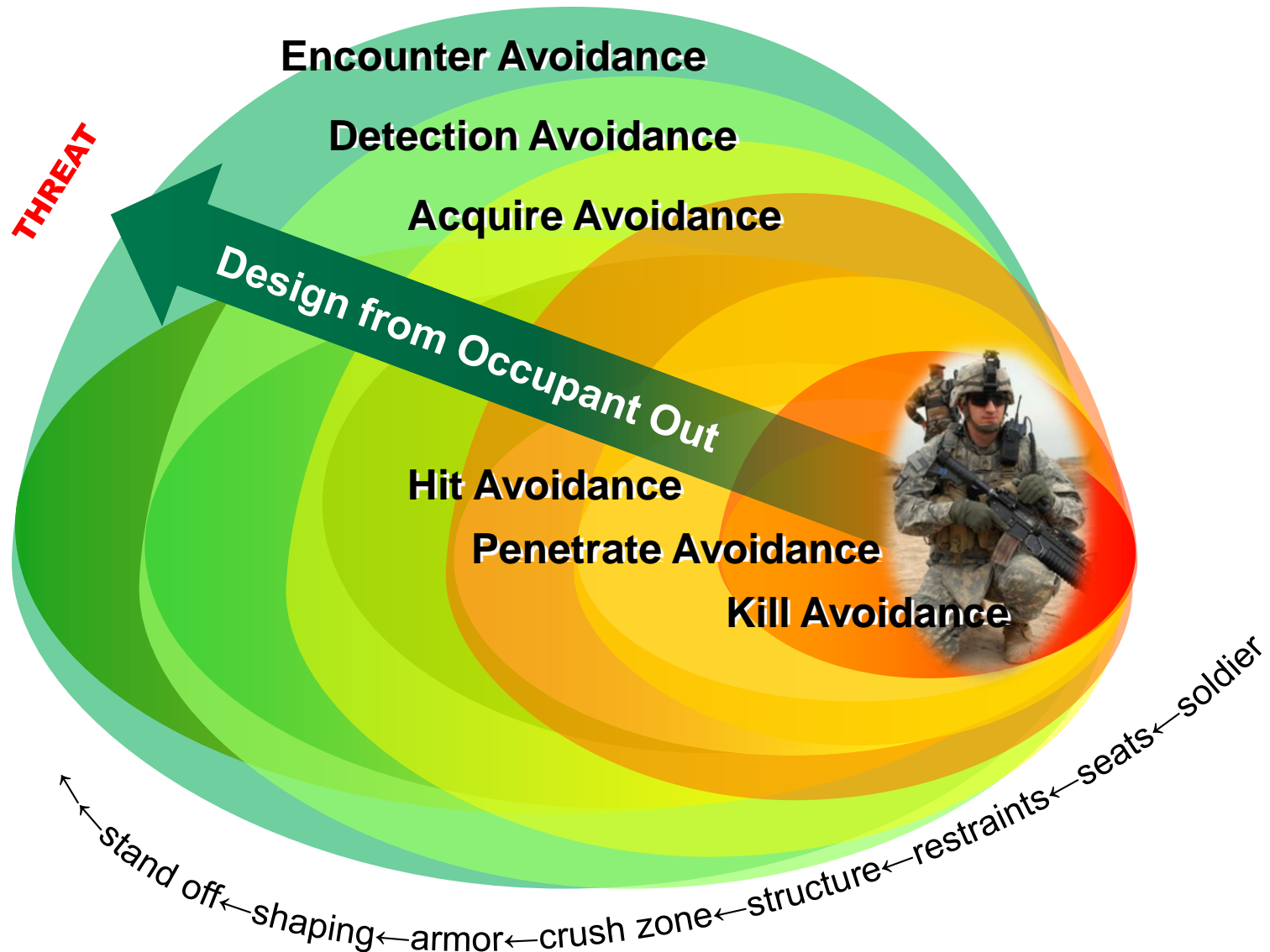
**Understand how to balance vehicle
“protection”, “performance” & “payload”
through an integrated survivability
approach that starts with occupant
protection.**

Cause Agent Breakdown 2002-2008



Munitions & Explosives Injuries by Body Region





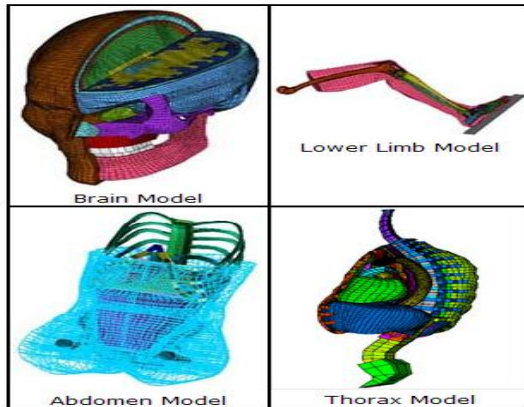
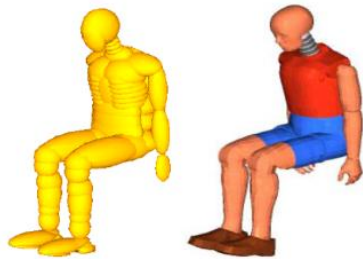


Building Blocks for Occupant Centric Design

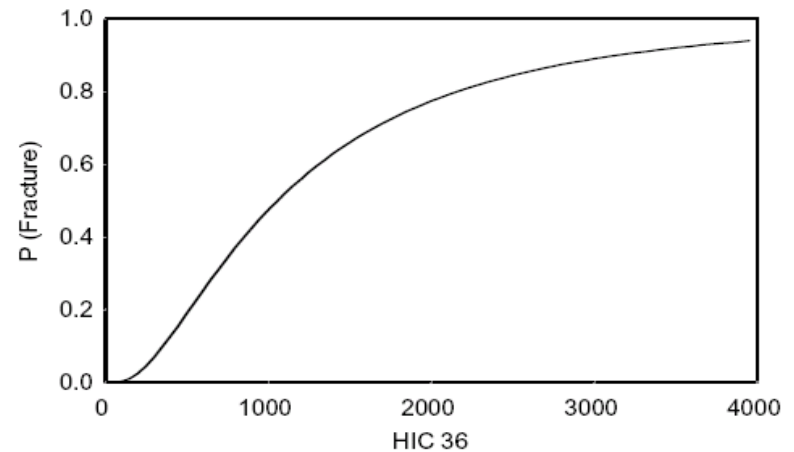


- 1. Requirements – Injury Criteria....what are we willing to accept?**
- 2. Platform Constraints**
- 3. Occupant Packaging**
- 4. External Threat Conditions**
- 5. Technology/Design Standards Implementation**
- 6. Space, Weight, Power, Cooling (SWaP-C)**
- 7. Concept Substantiation**
- 8. Prototype & Test**

Injury Assessment Tools



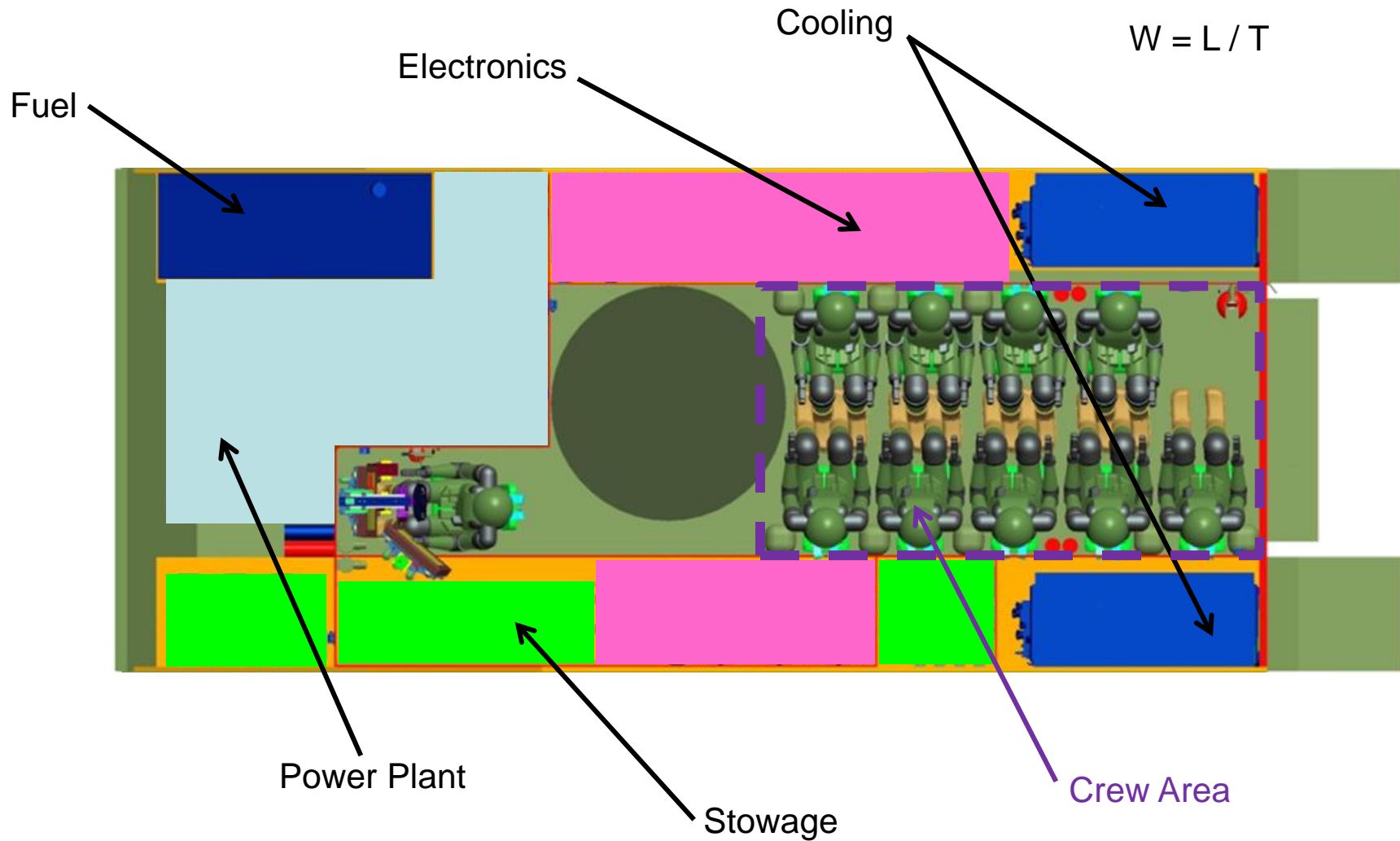
Example of One Criteria – Head Injury Criteria

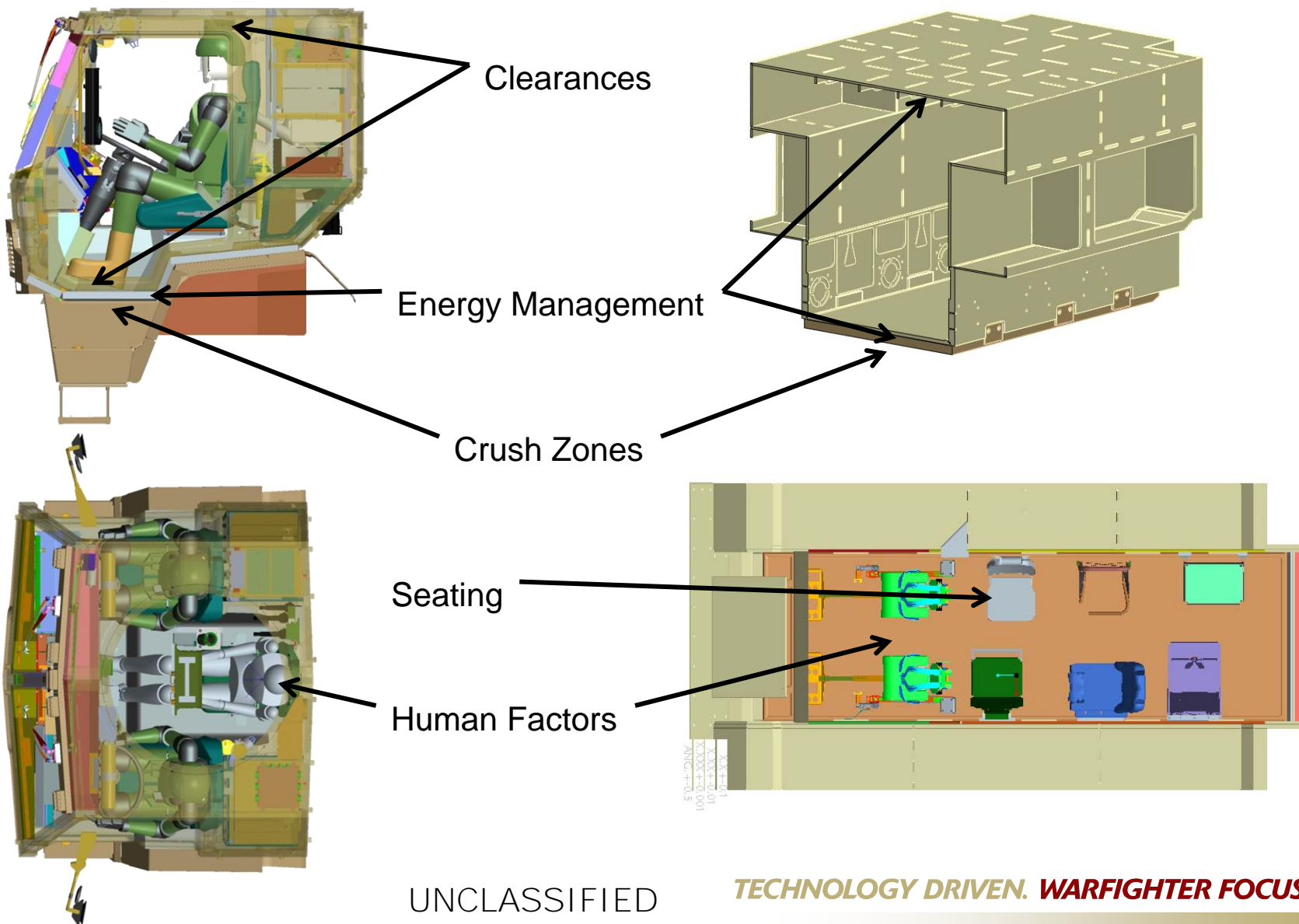


$$HIC = \left[\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} a dt \right]^{2.5} (t_2 - t_1)$$

Using analytical instrumented test devices, we can determine occupant injury response & subsequent risk acceptance

Example Personnel Carrier





4. External Threat Conditions



Stand-Off

Blast



Employment

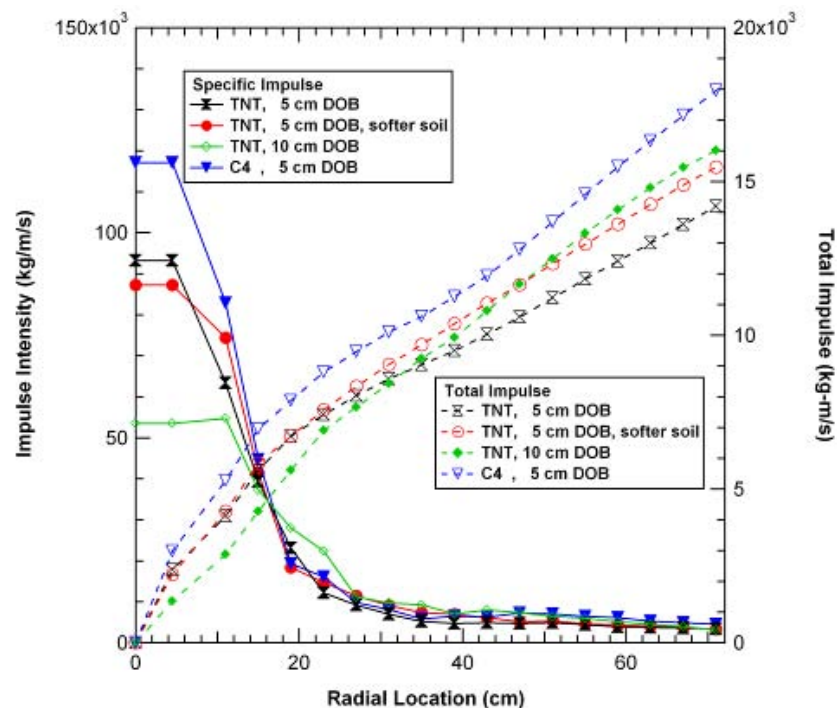
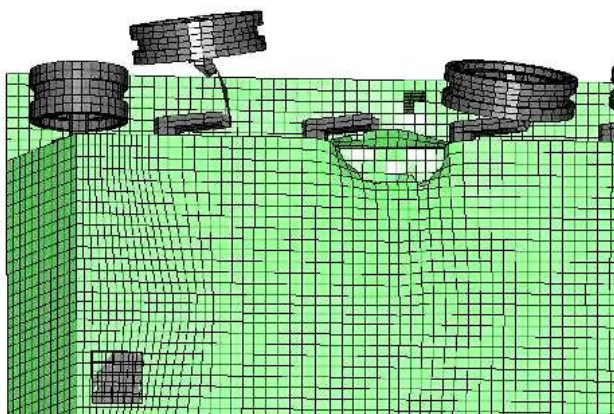
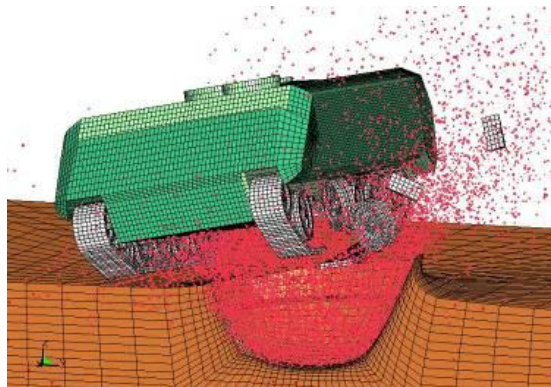


Fragments



Size (kg's)

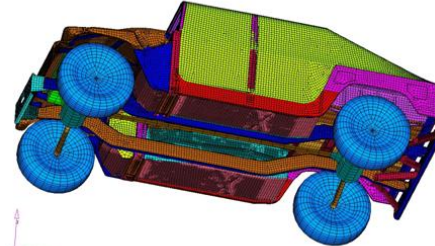
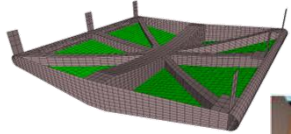
What are we concerned with?



Based on injury criteria, platform constraints, occupant packaging, external threat conditions, we model the baseline effects and resultant occupant injury

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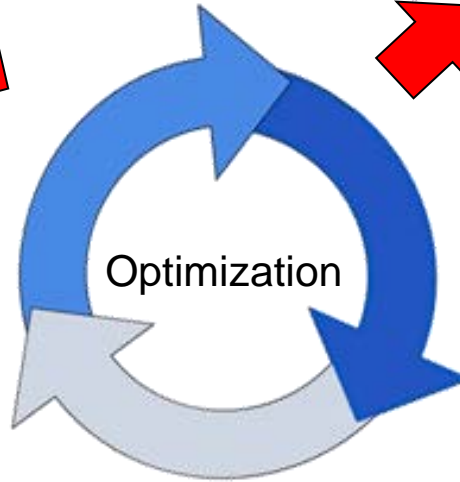
Technology/Design Standards Introduction



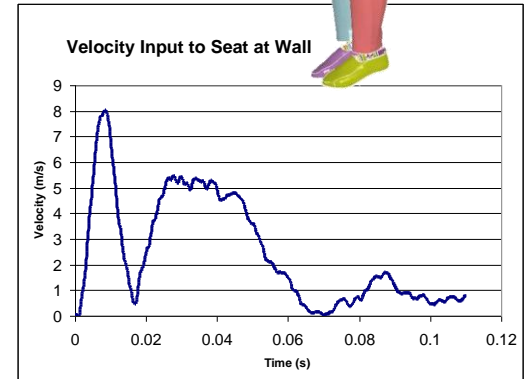
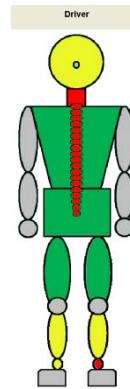
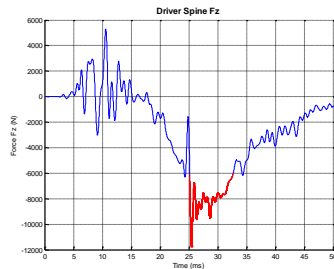
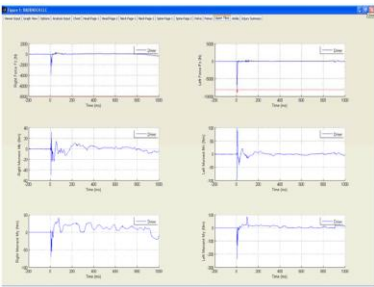
Platform Response



Occupant Response

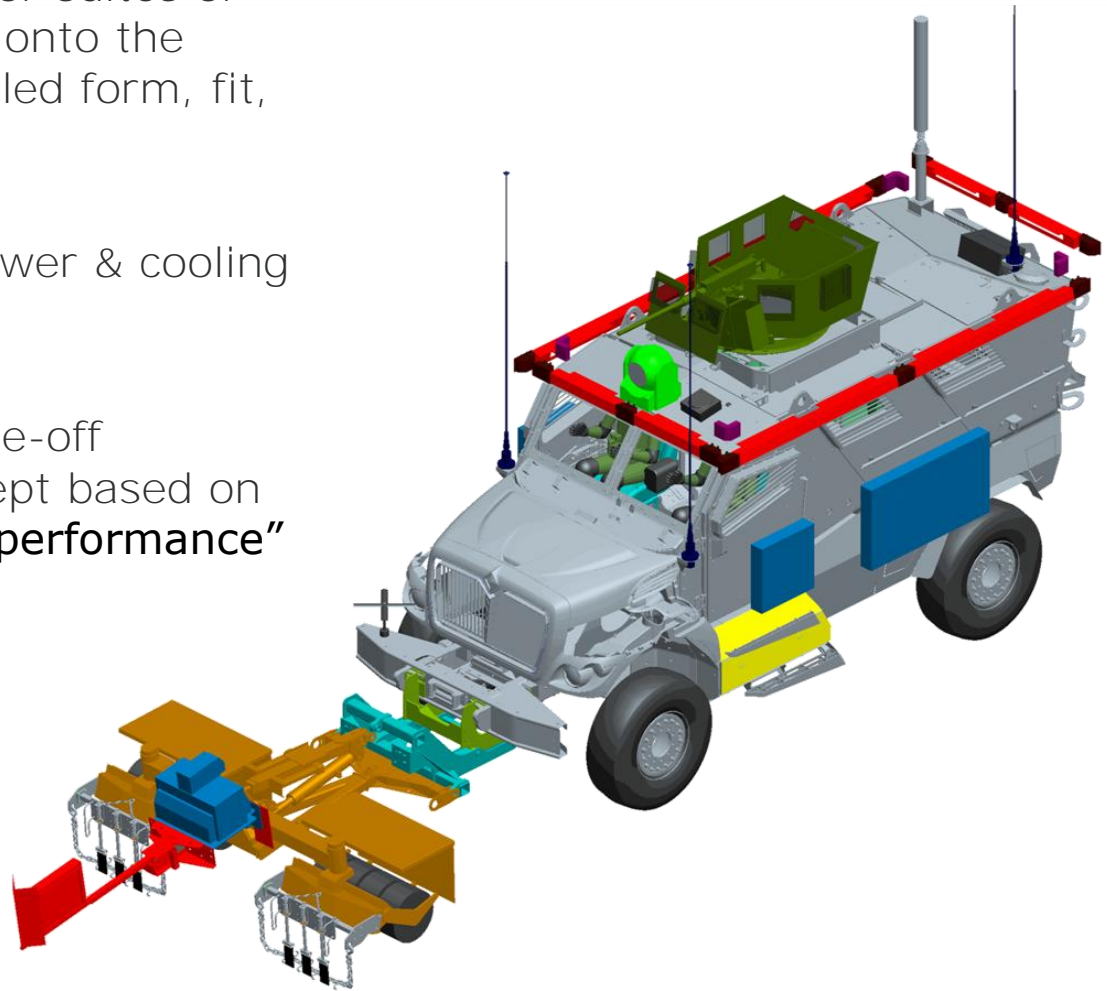


Injury Analysis

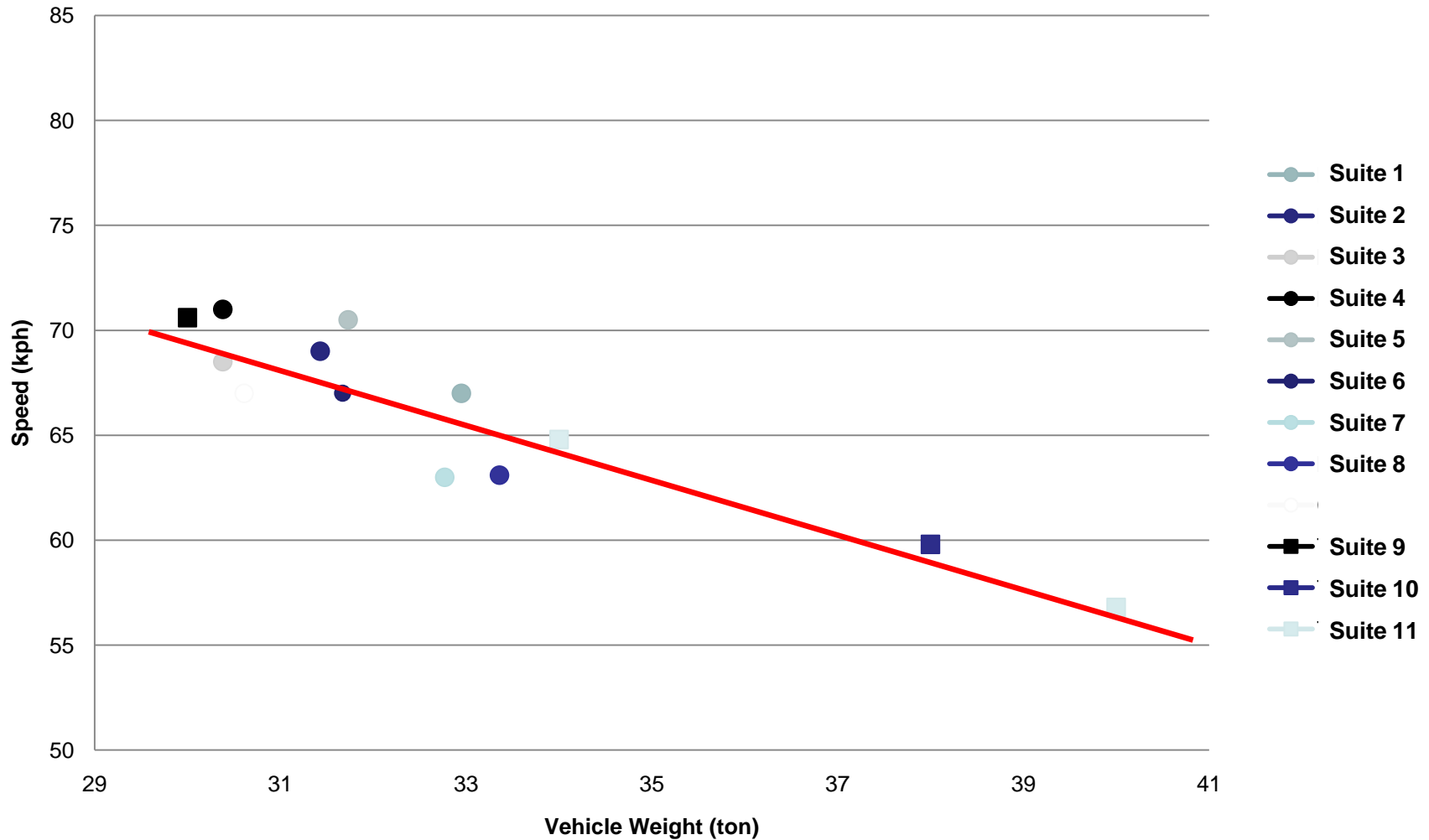


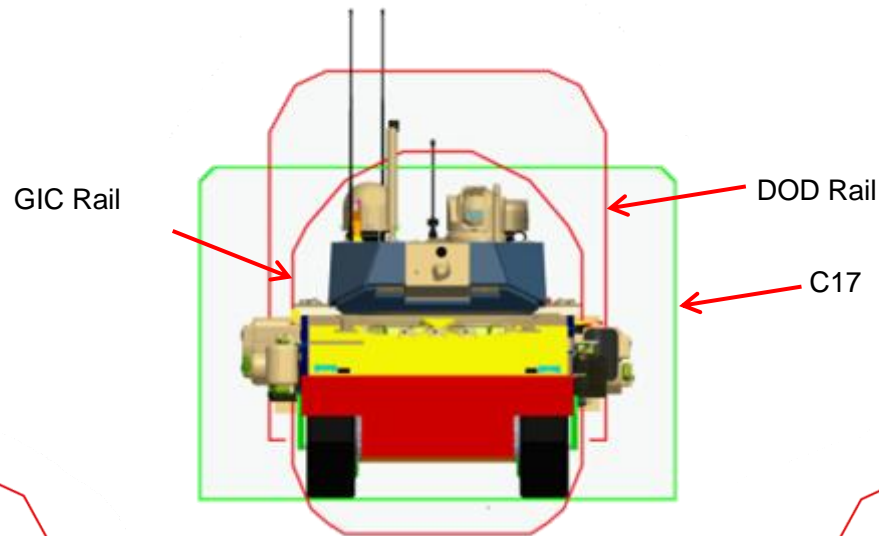
Criterion	Symbol	Threshold Values	Driver			
			Value	Duration	IARV	Pass/Fail
Upper Neck Nij	Nij	Nij >= 1	1.28	0.00	128%	Fail
Upper Neck Tension Curve	+Fz (N)	4170N @ 0ms, 3670N @ 35ms, 1100N @ 60-100ms	4162.27	0.00	127%	Fail
Upper Neck Compression Curve	-Fz (N)	4000N @ 0ms, 1100N @ 30-100ms	6108.00	0.00	153%	Fail
Upper Neck Twist Moment	Mz (Nm)	Mz >= 78Nm	81.73	0.00	105%	Fail
Spine DRlz	DRlz	DRlz >= 17.7	24.60	0.00	139%	Fail
Spine Lumbar Compression Curve	-Fz (N)	6673N @ 0ms, 3800N @ 30-100ms	11708.41	0.00	175%	Fail
Left Lower Tibia Compression Force	-Fz (N)	-Fz >= 6900N for 27yr old	6977.90	0.00	101%	Fail

- Proposed technologies and/or suites of technologies are integrated onto the candidate platform for detailed form, fit, function
- Begin the space, weight, power & cooling (SWAP-C) analysis
- Iterative physics based trade-off assessments to refine concept based on SWAP-C and “protection”, “performance” & “payload” .
 - Braking
 - Turning
 - Lane Change
 - Thermal Signature
 - Cooling
 - Acceleration
 - Data Flow
 - Human Factors
 - Power
 - Etc

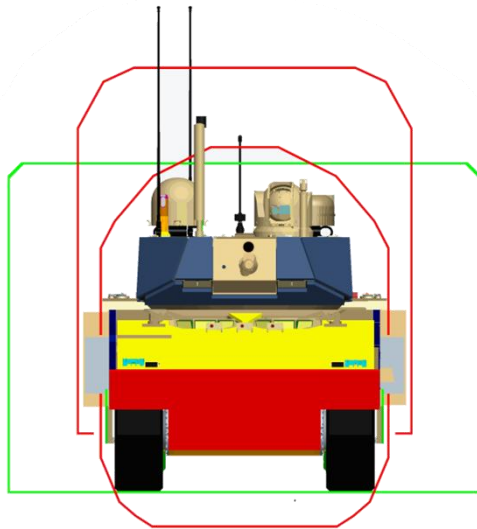


Top Speed Decreases as Proposed Protection Suite (weight) Increases

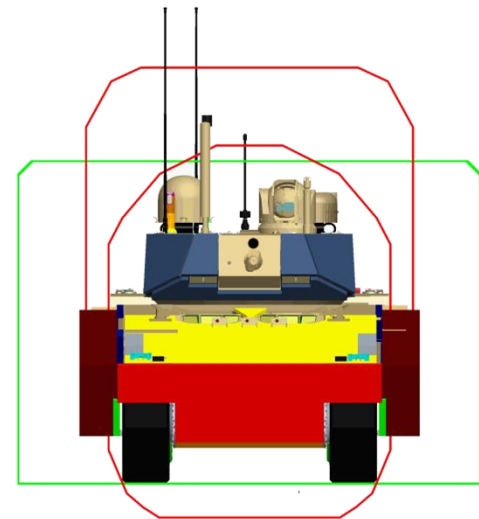




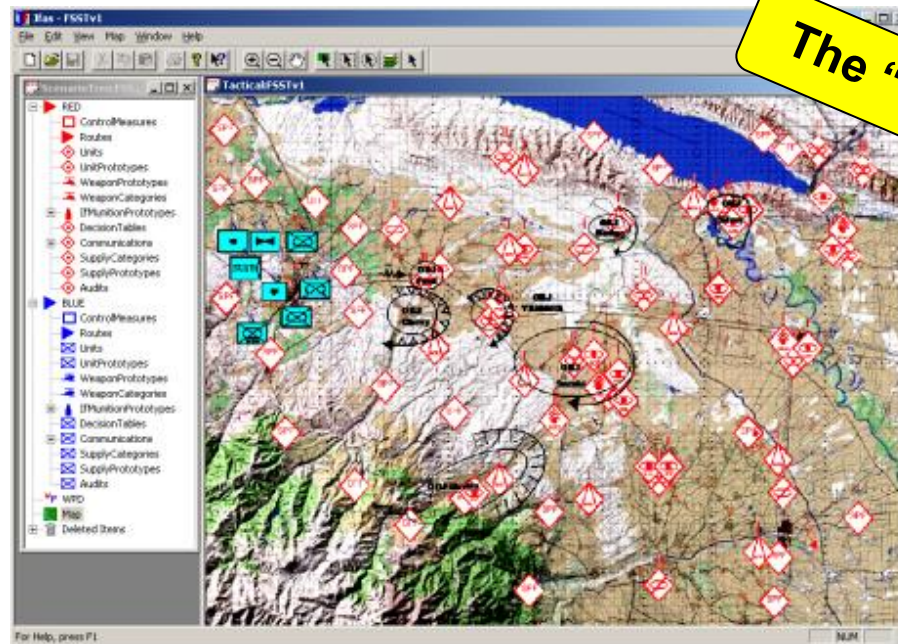
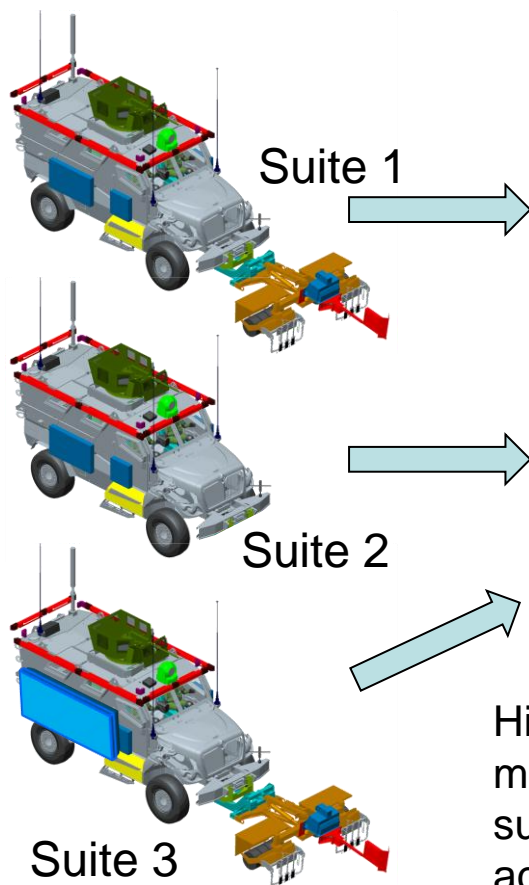
Suite 6



Suite 5



Suite 7



The "So What" test

High resolution force-on-force model provides engagement results in multi-day scenarios. Assess loss exchange ratios resulting from survivability suite changes to the candidate platform(s) taking into account:

Environment
Maneuver
Engagement
Engineer

Command & Control
Surveillance
Communications
Rearm

Concept substantiation via operational force-on-force modeling address trades and suite composition with sufficient fidelity to capture synergy and interference among technologies:

- Compare relative benefits of various technologies – APS vs. soft-kill CMs;
- Identify optimum combinations of other-than-armor survivability concepts;
- Isolate contribution of specific technologies – SigMan, Smoke;
- Identify benefits of tactical countermeasures – cued counterfire, maneuver.
- Performance of suite combinations against specific threats;
- Benefits and burdens of survivability technologies – laser filters, active sensors;
- Effect of design decisions on overall survivability – APS dead zones, armor vulnerabilities.



Baseline Platform Assessment



Technology Fabrication/Integration



Subsystem Component Test



Full-Up System Assessment

- The change in threat has necessitated a change in the way survivability is looked at.
- The Occupant Centric approach ensures we focus on the soldier first and build the necessary protection around the occupant from the inside out.
- The disciplined integrated survivability modeling process allows assessment of multiple survivability technologies over numerous threat environments in a manner providing system level technology contribution to survivability.
- The Occupant Centric approach optimizes & balances the critical attributes of system performance, payload & protection related to technology cost and risk, life cycle costs, and system burdens such as weight, volume, power, costs, or other quantifiable measures that impact the system or force.